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The Effectiveness of Technology-Enhanced Language Teaching Methods on Achievement in English: A Meta-Analysis

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Abstract

Integration of technology applications is now an essential part of language education and it has been extensively researched in many experimental studies comparing technology versus non-technology. This study sought to examine the effectiveness of technology-enhanced language instruction for achievement in English and investigate if various study and sample characteristics could moderate the overall effect size. Through a random-effects meta-analysis, technology-enhanced language learning and traditional learning in classroom were statistically analysed based on results from previous experimental studies conducted with Turkish learners of English in Türkiye. The results indicated that learning English with the use of technology is more effective than non-technology in conventional classroom setting with medium-to-large effects on not only overall achievement but also more specific learning outcomes including grammar, vocabulary, and writing. Moderator analyses showed that school level and item type significantly explained heterogeneity across studies. The results are discussed in relation to previous research, and suggestions for further research are given, with a particular emphasis on conducting primary studies in the field.

Keywords: Technology-enhanced language learning, Achievement in English, Meta-analysis.

Teknoloji Destekli Alternatif Öğretim Yöntemlerinin İngilizce Başarısı Üzerindeki Etkililiği: Bir Meta-Analiz Çalışması

Öz

Teknoloji uygulamalarının entegrasyonu dil eğitiminin önemli bir ögesidir ve teknoloji kullanımı ile geleneksel öğretimi karşılaştıran birçok deneysel çalışmada kapsamlı bir şekilde araştırılmıştır. Bu çalışmada teknoloji destekli dil öğreniminin İngilizce başarısındaki etkililiğinin ve birincil araştırmalara ilişkin çeşitli çalışma ve örneklem özelliklerinin ortalama etki büyüklüğünü değiştirip değiştirmediğinin saptanması amaçlanmıştır. Teknolojiyle desteklenmiş dil öğrenimi ve geleneksel öğrenme, Türkiye'de İngilizce öğrenen öğrenciler üzerinde daha önce yürütülen deneysel çalışmaların sonuçlarına dayalı olarak rastgele etkiler meta-analizi yoluyla istatistiksel olarak analiz edilmiştir. Sonuçlar, teknolojiyle desteklenmiş dil öğreniminin, teknolojinin kullanılmadığı geleneksel öğrenmeye göre, yalnızca genel başarı üzerinde değil, aynı zamanda dil bilgisi, kelime bilgisi ve yazma gibi dil öğreniminin daha spesifik yönleri üzerinde orta ila büyük derecede daha etkili olduğunu göstermiştir. Bu kapsamda yapılan moderatör analizleri, okul düzeyi ve madde türünün etki büyüklüklerindeki heterojenliği anlamlı bir şekilde açıkladığını göstermiştir. Çalışmada elde edilen sonuçlar önceki meta-analizler dikkate alınarak tartışılmış ve araştırmacılar için alandaki birincil araştırmalar odaklı öneriler sunulmuştur.

Anahtar kelimeler: Teknoloji destekli dil öğrenimi, İngilizce başarısı, Meta-analiz

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INTRODUCTION

Technology has long become indispensable for foreign language education through the application of a vast array of tools, devices and learning platforms. The implementation of technology serves for the purpose of not only assisting the instruction within the school but providing the opportunity to enhance learning outside the school. With more resources and types of technology being available to support L2 instruction throughout the years, the terminology has shifted towards technology-enhanced language learning (TELL) (Chang & Hung, 2019; Dooly & Masats, 2015; Walker & White, 2013).

A major concept in technology integration in order to learn languages is computer-assisted language learning (CALL), which can be broadly defined as "any process in which a learner uses a computer and, as a result, improves his or her language" (Beatty, 2003, p. 7). The development of computer-assisted language learning is closely related to the advancements in other fields such as educational technology and artificial intelligence (Chapelle, 2001). Warschauer (1996) analysed the development of CALL in three periods: (1) behavioural, (2) communicative, and (3) integrative. Gruba (2004) stated that in each of these periods the roles of learners, teachers and computers have undergone transformations. New technological innovations have enabled a more cooperative and creative language learning experience today (Beatty, 2003).

A second central theme is mobile-assisted language learning (MALL). Mobile devices of all kinds have made it possible for learners to utilize a wide range of learning materials to improve their language skills. The strength of mobile learning lies in its tenet of portability, which can be ascribed not only to the available technology but also to learners and learning itself (El-Hussein & Cronje, 2010; Pegrum, 2014). When one is engaged in MALL, one's learning is not bound to the limits of the classroom. When using mobile devices for language learning purposes, learners can engage in more authentic exchanges rather than instructional ones, which contributes to effective learning (Jee, 2011). Kim and Kwon (2012) mention that learners can become more independent by utilising various facilities in terms of materials, activities and resources.

Blended learning is another crucial aspect of how technology is adopted to enhance learning languages. Whittaker (2013, p. 12) argues that "blended learning is the term most commonly used to refer to any combination of face-to-face teaching with computer technology". Garrison and Kanuka (2004), on the other hand, considers blended learning as an efficient merge of traditional classroom instruction with online education, which is informed by the complex dynamics of a particular context. Thorne (2003) also emphasizes the capacity of blended learning in terms of providing an opportunity for learning in an individualized manner. Dudeney and Hockly (2007) uses the percentage of online materials, stating that more of the content (75%) is delivered online while the remaining occurs in conventional classroom settings; however, Whittaker (2013) states that percentages are not useful for an effective blend to take place.

Flipped classroom is a modern instructional approach creating an active learning atmosphere to meet the changing demands (Turan & Akdağ-Çimen, 2020). Unlike in traditional face-to-face education limited to the classroom, flipped learning requires that "students watch or listen to lessons at home and do their homework in class" (Fulton, 2012, p. 13). Bishop and Verleger (2013, p. 1) also viewed flipping as "a new pedagogical method", whereby constructivist and behaviourist theories of learning can be merged. Flipped approach to learning is demanding by nature as it requires transformation in terms of both students' and teachers' responsibilities (McGrath et al., 2017). As students are expected to carry out an active engagement in the process, they need to assume more responsibility for learning (Du, 2018; Jacot et al., 2014) and become autonomous learners (Suo & Hou, 2017). Flipped classroom is demanding for teachers as well since they assume the responsibility of preparing instructional materials that students will use to learn the content at home, which requires time and technological skills (Herreid & Schiller, 2013). Teachers are also expected to continuously support students so that they can act their roles as active and autonomous learners in the process (Evseeva & Solozhenko, 2015). Flipped learning transforms the use of time within the classroom as opposed to traditional instruction. The time spent within classroom must be organised to enable students to actively engage in practical activities (Başal, 2015) and is therefore more student-centred (Mehring, 2018).

Previous Reviews and Meta-Analyses

The effectiveness of language learning with the use of technology has been mostly confirmed by previous meta-analyses. Among early meta-analyses of CALL, Zhao (2003) found that CALL is more effective (d=0.81-1.12) compared to non-technology through synthesizing research into the impact of various technology

applications on the learning of foreign languages such as German, English, Arabic, French and Spanish. Taylor (2006) analysed the effectiveness of L1 glosses by means of CALL in comparison to traditional aids on L2 reading and found that CALL had a large effect size (g=1.09). More recently, Chiu (2013) investigated the effectiveness of CALL in terms of vocabulary learning, reporting an effect size of d=0.745. Grgurovic et al. (2013) meta-analysed 37 computer technology studies on English, Spanish, German, and Japanese as target language. They calculated the mean effect sizes based on different methodological characteristics of the studies, which ranged from 0.021 to 0.423; however, the studies that focused on English as target language yielded medium-sized average effects. In their comprehensive review of studies related to computer-assisted instruction, Sharifi et al. (2018) included 140 studies published between 1990 and 2016, and they found that CALL was more effective in English language learning (d=0.50) than learning through traditional instruction. The scope of three other meta-analyses were specifically related to the effectiveness of computer-assisted learning in Türkiye (Batdı, 2015; Dikmen & Tuncer, 2018; Tomakin & Yeşilyurt, 2013). Tomakin and Yeşilyurt (2013) included studies published between 2002-2010, and found a large effect size (d=1.43) for CALL among Turkish learners of English. On the other hand, Dikmen and Tuncer (2018) analysed the effectiveness of computer-assisted learning on academic achievement in general in studies published over a period of ten years from 2007 to 2017, and they calculated a large average effect size (d=1.043) associated with the use of computer technology in instruction. However, their study was not exclusive to learning foreign languages since studies on achievement in other courses were involved in their meta-analysis. Similar to Dikmen and Tuncer's (2018) study, Batdı (2015) synthesized the findings from studies on academic achievement in various courses, which were published between 2006-2014, and found a large effect size (d=1.13).

There are also meta-analyses concerning the effectiveness of mobile-assisted learning. Sung et al. (2015) investigated the effectiveness of MALL on L2 achievement over 43 studies published between 1993 and 2013, and calculated an average effect of 0.531. Taj et al. (2016) covered the period from 2008 to 2015 and included 13 studies on achievement in English. The effect size in their study was found to be of small size (ES=0.425). More recently and more specifically, Lin and Lin (2019) analysed the effectiveness of MALL on the vocabulary achievement and found a large effect size (g=1.005). The effect of MALL was also depicted from general academic achievement perspective in two other studies focusing on different courses. One such study was conducted by Güzeller and Üstünel (2016), who included 10 studies from 2009 to 2014, and calculated the average effect size as g=0.849 supporting the use of mobile devices in learning. On the other hand, Yıldız-Avcı (2018) meta-analysed 16 studies between 2008 and 2018, and found that mobile-assisted learning was an effective approach with an average effect size of g=0.607.

Meta-analyses on the impact of blended learning on achievement have reported inconsistent results. Three meta-analyses conducted including studies on samples of university students (Bernard et al., 2014; Means et al., 2009; Vo et al., 2017) found low effect sizes (g=0.33, g=0.35, g=0.38 respectively). Two other meta-analyses presented the situation from a national perspective (Batdı, 2014; Çırak-Kurt et al., 2018). Batdı (2014) was limited to nine studies and calculated the average effect size as d=0.66. However, Çırak-Kurt et al. (2018) included 27 studies to analyse the effectiveness of blended learning in comparison to traditional instruction. They found a large effect size (g=1.042), which supports the effectiveness of blended learning with regard to achievement.

Finally, several systematic reviews and meta-analyses have been conducted involving the studies on flipped classroom. In their systematic review, Uzunboylu and Karagözlü (2017) indicated that the number of studies on flipped learning increased as of 2012 and these studies were mostly conducted utilizing experimental design and in higher education settings. Their finding was quite similar to Kozikoğlu (2019) in that the studies were mostly experimental and conducted in higher education. Filiz and Benzet's (2018) review of previous studies were limited to the use of flipped learning approach in foreign language education and such topics as achievement, attitude, academic performance, and writing performance were mostly researched in the studies reviewed. On other hand, there are several meta-analyses in the literature that investigated the effectiveness of flipped learning on achievement. Karagöl and Esen (2018) included 55 studies and found that flipped learning was more effective than traditional instruction (g=0.566). van Alten et al. (2019) included 114 studies which examined the effectiveness of flipped learning in achievement and calculated an effect size of g=0.36. Similarly, Lag and Saele (2019) determined that flipped classroom was superior to traditional learning through the meta-analysis of 272 studies with a mean effect size of g=0.35.

While the studies reviewed above all provide valuable insights into the role of technology applications in the teaching and learning of languages in the contexts of the studies, they have not provided sufficient evidence to

fully understand how effective TELL was for Turkish learners of English for two main reasons. First, the generalizability of the previous studies is limited since they were interested in different foci, either including only an aspect of technology or investigating a certain aspect of language learning. Secondly, although it is well documented that there have been a large number of experimental studies in foreign language teaching in Türkiye (Özmen et al, 2016; Yağız et al, 2016), most of the literature have not been included in previous meta-analyses due to study inclusion criteria and a narrower period of literature included. Therefore, building on this gap in the literature, this study will provide a more comprehensive picture of the effectiveness of various forms of technology in terms of achievement in English for Turkish learners by utilizing a larger sample of previous experimental studies collected from multiple sources of publication, help to identify the patterns, trends and certain discrepancies in the literature to inform future research in the field. Through synthesizing the findings of the previous studies, this study sought to investigate how effective technology-enhanced language learning methods are for the achievement of Turkish learners of English. We address these research questions in the study:

1.What is the effectiveness of technology-enhanced language learning on grammar, vocabulary, writing, and overall achievement?

2.Does the effect of technology-enhanced language learning on overall achievement differ by moderator variables?

It should be noted that the choice of grammar, vocabulary and writing as well as overall achievement was mainly guided by the available literature on technology-enhanced language learning. As meta-analysis builds upon existing literature in order to provide a more comprehensive summary in a particular field, the number of studies that can be meta-analysed is critical to ensure that the results are reliable and generalizable (Borenstein et al., 2009). Besides, Zengin and Aksu (2017) found out that the majority of studies examining achievement in English language learning through technology integration in Türkiye tend to place greater emphasis to vocabulary learning as opposed to other skills. Similarly, Kartal (2020) stated that writing and vocabulary skills were two of the most common areas where technology has been found to be most effective. Therefore, we focus on analysing the effectiveness of technology-enhanced language learning with respect to the most commonly researched outcomes such as grammar, vocabulary and writing as well as overall achievement.

METHOD

Research Design

The impact of technology-enhanced language learning on Turkish learners' achievement in English was explored through meta-analysis. Meta-analysis is a statistical methodology of synthesizing the results of primary studies on a particular subject (Littell et al., 2008). In line with common recommendations for steps involved in the procedure of a meta-analysis (Ellis, 2010; Field & Gillett, 2010; Rosenthal & DiMatteo, 2001), this study is conducted through the following steps: (1) collecting the studies, (2) evaluating them based on the inclusion criteria, (3) coding study characteristics, (4) calculating effect sizes, (5) computing the mean effect size, (6) assessing publication bias and heterogeneity, and (7) interpreting the results within the research field.

Literature Search

The literature search was completed through both national (*Ulusal Tez Merkezi*, *Dergipark*) and international databases or search engines (*ERIC, Taylor & Francis Online*, *Jstor, ScienceDirect, Ebscohost,* and *Google Scholar*). Keywords utilized in the exhaustive search involved the combination of the following terms in both English and Turkish to address the dimensions of the research questions: *instruction, learning, teaching, computer assisted language learning, mobile assisted language learning, blended learning, flipped classroom, achievement,* and *experimental*. The database search yielded a total of 2356 studies. Following an initial title and abstract screening, we reviewed the rest of the studies using the following criteria for inclusion.

Inclusion Criteria

Studies retrieved from the databases were screened based on several criteria: (1) The publishing date of the study is 2018 the latest, (2) the full text is accessible in either English or Turkish, (3) the study investigated student achievement in English as the outcome measure, (4) the sample is made up of EFL learners in Türkiye, (5) pretest-posttest control group design was employed, (6) the teaching adopted for treatment group is computer-assisted, mobile-assisted, blended or flipped classroom, (7) instruction in the control group is delivered in traditional face-to-face manner, and (8) statistics required for effect size calculation are reported.

After the elimination of the studies that (1) investigated achievement in other subjects and languages, (2) did not include Turkish learners of EFL, (3) did not have a control group, (4) were not accessible in full-text and (5) did not present required statistics for effect size calculation, 52 primary studies were found to be eligible for inclusion in the meta-analysis.

Coding Procedure

First author was the chief coder in the study. After he coded all the studies, they were randomly assigned to four other coders, who coded 13 studies each. Two measures were applied to check the reliability in the coding process. Agreement rate was calculated separately for each set of studies between the researcher and the other coders. Average agreement rate ranged from 88% to 92%. Also, Cohen's Kappa coefficient was calculated independently in each set as in agreement rate. Cohen's Kappa ranged from 0.82 to 0.88 (p<.001), which indicates a high level of agreement (Landis & Koch, 1977). All the disagreements were later resolved through discussion with the other coders.

Calculation and Interpretation of Effect Size

The effect size index employed is Hedges' *g*, which provides a correction for Cohen's *d* value since the latter can be biased with small sample sizes. If a study involved multiple comparisons of achievement including sub-skills, these effect sizes were averaged to compute the mean effect size for overall achievement. However, in the analysis of the effectiveness of TELL on achievement in sub-skills as dependent variable, the effect sizes from the relevant comparisons were retained and used for calculating the mean effect size for a particular sub-skill. Random effects model was preferred as statistical model for this study on the assumption that the true effect may vary across studies (Field & Gillett, 2010). Random effects analysis was chosen also because it makes it possible to make inferences beyond the observed studies (Hedges & Vevea, 1998). Finally, the estimated effect sizes in this study were interpreted in line with field-specific guidelines offered by Plonsky and Oswald (2014), who recommended adopting the benchmarks of small (d=0.40), medium (d=0.70), and large effect (d=1.00) for mean differences between groups (experimental vs. control) since these can be best at explaining the results within the framework of L2 research. All analyses are conducted using meta-analysis packages *metafor* (Viechtbauer, 2010) and *meta* (Balduzzi et al., 2019) in *R software* (R Core Team, 2021).

Publication Bias

Publication bias is considered to present a risk for the validity of meta-analysis (Jin et al., 2015); therefore, the representativeness of primary research in meta-analysis should be considered. In this study, the assessment of publication bias was performed through Begg and Mazumdar's rank correlation test (Begg & Mazumdar, 1994) and Egger's regression test (Egger et al., 1997). Duval and Tweedie's trim and fill method (Duval & Tweedie, 2000) was also implemented in case of an indication of publication bias to correct for a possible bias.

FINDINGS

Study Characteristics

52 primary studies were published between 1994 and 2018. The studies selected were proceedings (n=3), journal articles (n =13), master's theses (n =26) and PhD dissertations (n=10). The instruction mode in the treatment group of the studies were blended (n =5), CALL (n=28), flipped (n=9) and MALL (n=10). Learner samples were pre-school (n=2), secondary (n=7), high school (n=5), English Prep Class (n=26) and university (n=12). Length of treatment were "1-4 weeks" (n=20), "5-8 weeks" (n=22), "9-15 weeks (n=8), and n/a (n=2). The researchers of the studies participated as "one or both of the teachers" (n=34), "none of the teachers" (n=7) and n/a (n=11). Considering the types of teacher effect in the studies, they were the same teacher ((n=31), different teacher (n=10) and n/a (n=11). The achievement tests used were developed (n=31), adapted (n=5), or an existing test (n=16). In the achievement tests, objective (n=29), open-ended (n=11) and mixed type (n=11) items were used. Finally, sample sizes varied: "1-20 students" (n=23), "21-30 students" (n=20) and "more than 30" (n=9).

Main Effect Analyses

Main effect analyses were performed to compute the effectiveness of TELL on sub-skills such as grammar, vocabulary and writing achievement as well as overall achievement, and the results of these meta-analyses are presented in Table 1.

Table 1. Meta-Analytic Results of Effect Sizes

Dependent Variable	*k*	*g*	SE	95% CI	*z*	*p*	*Q*	I^2
Grammar	14	0.600	0.122	[0.361, 0.839]	4.919	<.001	32.119	59.525
Vocabulary	23	0.698	0.084	[0.534, 0.862]	8.331	<.001	41.592	47.105
Writing	10	0.940	0.180	[0.588, 1.293]	5.227	<.001	27.388	67.138
Overall	52	0.729	0.082	[0.568, 0.891]	8.844	<.001	198.985	74.370

In terms of grammar achievement, 14 studies that reported comparisons were meta-analysed to compute the mean effect size of the impact of TELL. The results show a medium effect size (g=0.600, SE=.122, 95% CI: [.568, .862]), which was found to be significant (z=4.919, p<.001). The distribution of these effect sizes was found to be heterogeneous (Q=32.119, p<.001). In the analysis of the effect of TELL on vocabulary achievement, 23 studies that involved comparisons were included in the meta-analysis. TELL was found to have a medium-sized effect on vocabulary achievement (g=0.698, SE= .084, 95% CI: [.534, .862]) and this result was statistically significant (z=8.331, p<.001). Heterogeneity test indicated that the distribution of effect sizes in terms of vocabulary achievement was heterogeneous (Q=41.592, p<.05). The other sub-skill investigated in the included studies was writing achievement, and 10 studies reported the required statistics for effect size calculation in writing achievement. According to the results, the effect of TELL on writing achievement was of medium-to-high level (g=0.940, SE=.180, 95% CI: [.588, 1.293]), which was statistically significant (z=5.227, p<.001). Finally, 52 studies that met the inclusion criteria were synthesized to estimate the overall effectiveness of technology-enhanced language learning methods. The mean ES was calculated as g=.729, SE=.082, 95% CI: [.568, .891] under the random effects model. This result was found to be significant (z=8.844, p< .001), indicating a medium-sized average effect according to Plonsky and Oswald's (2014) rule of thumb for ES classification in L2 research. Forest plots of the studies in each meta-analysis are provided in *Appendix 1-4*.

Table 1 also presents statistics regarding the heterogeneity across the studies included. The distribution of the effect sizes obtained from 52 studies was found to be heterogeneous, (Q=198.985, p<.001) with I^2=74.370 showing a high level of heterogeneity. It was concluded that the differences between the included studies cannot be attributed to sampling errors only. Therefore, moderator analyses were performed to determine whether the effect sizes differ by moderator variables related to study and sample characteristics.

Moderator Analyses

Moderator analyses were conducted to determine if the effect of TELL on overall achievement in English was moderated by study and sample characteristics. The results of moderator analyses are presented in Table 2.

Table 2. Moderator Analysis Results

Variables	*k*	*g*	SE	95% CI		Q_B	df	*p*
				Lower	Upper			
Publication Type						4.346	3	.226
PhD dissertation	10	0.923	.189	.553	1.292			
MA theses	27	0.800	.115	.575	1.025			
Journal articles	12	0.508	.172	.171	.845			
Proceeding	3	0.352	.337	-.309	1.012			
Instruction Mode						7.608	3	.055
Mobile-assisted	10	1.084	.183	.726	1.443			
Blended	5	0.956	.268	.430	1.481			
Flipped	9	0.800	.193	.421	1.179			
Computer-assisted	28	0.540	.110	.325	.754			
School Level						16.255	4	.003
Pre-school	2	0.314	.378	-.427	1.056			
Secondary school	7	0.673	.197	.287	1.059			
High school	5	1.047	.243	.570	1.525			
Prep Class	26	0.947	.104	.727	1.136			
University	12	0.262	.151	-.035	.559			
Researcher Effect						2.966	2	.227
One of teachers	34	0.826	.107	.616	1.037			
None of teachers	7	0.654	.183	.295	1.012			

Unspecified	11	0.486	.172	.150	.822			
Teacher Effect						2.355	2	.308
Different	10	0.833	.163	.514	1.151			
Same	31	0.766	.120	.531	1.001			
Unspecified	11	0.533	.141	.256	.810			
Achievement Test						1.379	2	.502
Developed	31	0.802	.106	.595	1.010			
Existing	16	0.648	.153	.347	.948			
Adapted	5	0.527	.257	.022	1.032			
Items on Achievement Test						7.990	2	.018
Objective	29	0.572	.109	.359	.785			
Open-ended	11	0.954	.165	.631	1.277			
Mixed	11	1.025	.136	.759	1.291			

Publication Bias Assessment

Publication bias was assessed using two statistical tests based on funnel plot asymmetry. Both Egger's regression test and Begg and Mazumdar's rank correlation test were found to be nonsignificant in both meta-analyses on grammar (p=.16, p=.32 respectively) and vocabulary achievement (p=.782, p=.369). For writing achievement, rank correlation test was found to be nonsignificant (p=.107), while Egger's regression test indicated a funnel plot asymmetry (p=.042). Therefore, Duval and Tweedie's trim-fill test was performed for any missing studies, which yielded three studies added. The adjusted effect size as a result of trim and fill test was found to be g=.662 (95% CI: [.271, 1.054]), which could still be interpreted as of the same magnitude compared to g=.940 prior to trim and fill analysis considering Plonsky and Oswald's (2014) benchmarks. Regarding the meta-analysis on overall achievement, rank correlation test was nonsignificant (p=.089). However, as was the case in writing achievement, Egger's regression test was found statistically significant (p=.018) in the analysis of overall achievement. Trim and fill method suggested 10 studies trimmed and filled, which yielded an adjusted effect size of g=0.542 (95% CI: [.340, .714]). However, this did not change the interpretation of the magnitude of the effect in accordance with Plonsky and Oswald's (2014) benchmarks. As a result, it can be concluded that publication bias was not a big concern for the interpretation of the effectiveness of TELL on achievement in English as reported in this study. Funnel plots of the studies in each meta-analysis are provided in *Appendix 5*.

DISCUSSION & CONCLUSION

The current study aimed to examine the effects of TELL on achievement in English among Turkish learners of English. We also anticipated a variability in effect sizes across studies and performed moderator analyses to understand whether the effects vary by study and sample characteristics. The results revealed that TELL brings medium to large positive effects to learning English among Turkish learners of English. This is a similar finding when compared to other meta-analyses conducted previously.

The high effect size (g=1.084) found in studies on mobile-assisted language learning was in line with other meta-analyses (Güzeller & Üstünel, 2016, Lin & Lin, 2019), showing that mobile-assisted language learning can indeed increase the achievement of learners of English. On the other hand, our finding was higher than those found in two other meta-analyses (Sung et al., 2015, Taj et al., 2016), in which medium-sized effects were found for mobile-assisted language learning. Regarding blended learning, several previous studies concluded blended learning had a low effect on achievement (Bernard et al., 2014, Means et al., 2013, Vo et al., 2017). In the current study, blended learning had a medium to high effect size (g=0.956), which is quite similar to the result of Çırak-Kurt et al. (2018), in which primary research in Türkiye was synthesized with the aim of examining the impact of blended learning (g=1.042). This indicates that blended learning has a high potential in increasing the academic achievement among Turkish learners. A medium effect size (g=0.800) was associated with flipped learning studies included in this meta-analysis, which is indeed higher than other meta-analyses reviewed (Cheng et al., 2019, Karagöl & Esen, 2018, Lag & Saele, 2019, Van Alten et al., 2019). They included studies that examined achievement in not only English but other subjects as well, which might show that flipped learning may not be effective in all subject areas. However, two other recent reviews specifically related to language learning reported somewhat similar findings. Arslan (2020) conducted a systematic review of 78 studies and found that flipped classroom was frequently associated with positive results with respect to writing and speaking. Also, Vitta and Al-

Hoorie (2020) reported a somewhat similar effect size of g=0.58 after accounting for publication bias in their meta-analysis. Previous findings related to the effectiveness of computer-assisted language learning reported medium-sized effects on achievement (Camnalbur, 2008; Grgurovic et al., 2013; Sharifi et al., 2018). Our finding is similar (g=0.540) to these meta-analyses. However, computer-assisted language learning was found to have higher effect sizes in some studies (Tomakin & Yeşilyurt, 2013; Zhao, 2003), which both included studies over a shorter span of time than those in this study. In addition, some of the included studies in Zhao's (2003) meta-analysis examined achievement in other languages. This indicates that computer-assisted language learning might have differing effects across various target languages.

Moderator analysis regarding teacher effect indicated that the effect sizes were higher when experimental and control groups were taught by different teachers compared to those taught by the same teacher, albeit not statistically significant. This finding is different from Chang and Lin's (2013) study. In their meta-analysis of web-based English instruction in Taiwan, Chang and Lin (2013) calculated a slightly bigger effect size when the same teacher was employed in both experimental and control groups. However, their finding did not reach statistical difference either, which indicates further studies are needed to fully investigate the potential impacts of who teaches the experimental and control groups.

Our finding regarding the item type in achievement tests as a moderator variable was found to be statistically significant. We found that when achievement is measured based on achievement tests made up of both objective and open-ended items, the effect size is larger, and only open-ended and only objective items yielded lower effect sizes. This finding is contrary to In'nami and Koizumu's (2009) meta-analysis of test format effects. In'nami and Koizumu (2009) identified that multiple-choice tests were easier in both reading and listening compared to tests of open-ended items. However, it should be noted that In'nami and Koizumu's (2009) study analysed the effects of test format in the performance of reading and listening skills, whereas achievement in our study has been operationalized as overall success in English including not only reading and listening but also writing, speaking, grammar, and vocabulary learning as measured in the primary studies.

The implications of these meta-analytic results regarding the effectiveness of different types of technology-enhanced language teaching methods can be examined through the lens of various specific factors including the type of technology used, instructional design adopted and contextual factors. First, it should be noted that the high effect size associated with mobile-assisted language learning suggest that mobile devices are a useful tool to improve language learning outcomes. This might be due to the fact that mobile devices offer students the flexibility to learn anytime and anywhere (Kukulska-Hulme & Shield, 2008), which can in turn enhance motivation and learning (Liu & Chu, 2010). In contrast, a somewhat lower effect size obtained from studies on computer-assisted language learning might have resulted from the fact that computer-assisted language learning is mainly limited to classroom settings, which might restrict motivation and engagement. On the other hand, the implementation of blended learning requires careful instructional design informed by complex contextual factors (Garrison & Kanuka, 2004), which may not always be very well-executed in practice. In the case of blended learning, the higher effect size found in this study as opposed to previous meta-analyses may be due to the unique implementation of blended learning in the studies reviewed, most of which utilized learning management systems specifically designed to complement the coursebooks used, which may have contributed to the effectiveness of blending (Kintu et al., 2017). Similarly, the effectiveness of flipped learning may depend on contextual factors such as learner preparedness and engagement (Li & Li, 2022) as students are typically expected to deal with instructional materials before attending the class to allow for active and interactive learning environment during class time.

The generalizability of the results of this study should be evaluated considering a number of limitations associated with the inclusion and coding of primary studies reviewed. Firstly, we aimed to include as many primary studies as possible that meet the inclusion criteria to minimize publication bias. Nevertheless, it is almost impossible to be completely certain that no studies were left out. Although we included studies from as early as 1994, older studies might not have been available on the databases we searched through. Considering the development of technology and technology use in education over the years, the effects should be interpreted in line with the time span of the included studies. In addition, the achievement tests used in the primary studies have all been examined carefully and coded appropriately. However, it is likely that some items tested multiple outcomes in language learning. This is why the results of the relevant moderator analysis need to be evaluated in line with this potential overlap between multiple skills. Another limitation is related to the moderator analyses in which relevant moderator variables are not reported in some primary studies. For example, the moderator analyses regarding the teacher effect and researcher effect were performed with one sub-group each formed by 11 studies which did not report any information regarding the role of teacher and researcher, so they were coded as

"unspecified". However, the results might have been more complete if the related information had actually been reported in the studies.

In conclusion, our meta-analysis yielded evidence to the superiority of technology-enhanced language learning to non-technology in terms of achievement in English among Turkish learners of English. Based on this result, we recommend English teachers implement technology in their classrooms. However, it is necessary to consider that good teaching requires a careful pedagogical design of how to implement technology (Sharifi et al., 2018). Caution should be exercised by teachers in not only managing the technical aspects of technology use but also identifying the most appropriate approach for their own contexts (Zhou & Wei, 2018). Given the importance of theoretical grounds of how technology is implemented in L2 teaching, we would like to recommend future researchers conduct experimental research studies into the effects of technology use supported with learning strategies. In addition, our findings regarding the methodological and sample characteristics of the studies included seem to indicate that there is room for more research into the effects of technology-enhanced language learning at primary school level, which is critical for the learning in later stages. Future researchers could also conduct more studies to investigate how technology-enhanced language learning influences achievement in reading, listening, and speaking skills since the number of studies that examined these was limited in our meta-analysis, which would further increase our understanding of the effectiveness of technology in learning a language.

Statements of Publication Ethics

The author(s) of this study complied with all the rules specified within "*Higher Education Institutions Scientific Research and Publication Ethics Regulations*". Since this study is a meta-analysis of previously published studies, it does not require ethical committee approval.

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Conflict of Interest

We hereby declare that there is no conflict of interest involved in this study.

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indicates the studies included in the meta-analysis.

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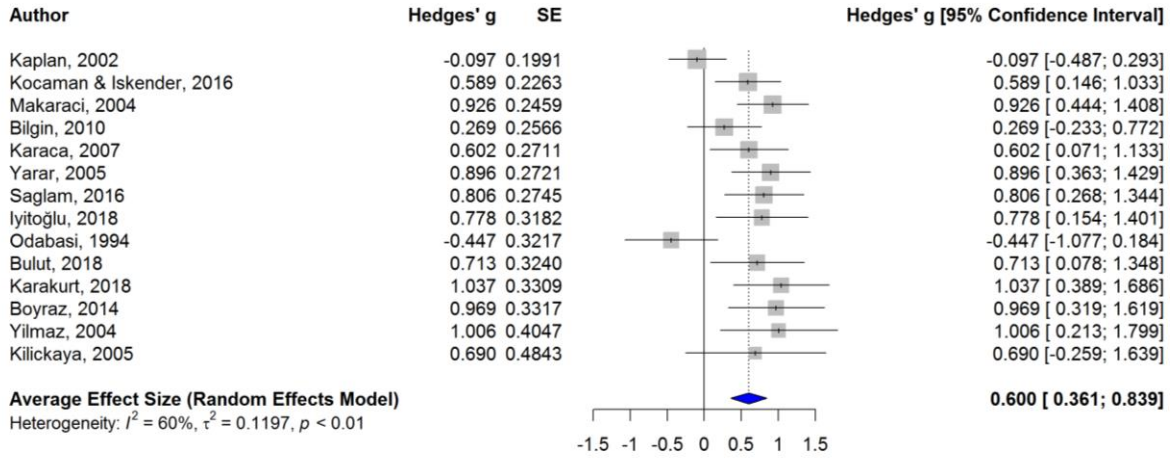
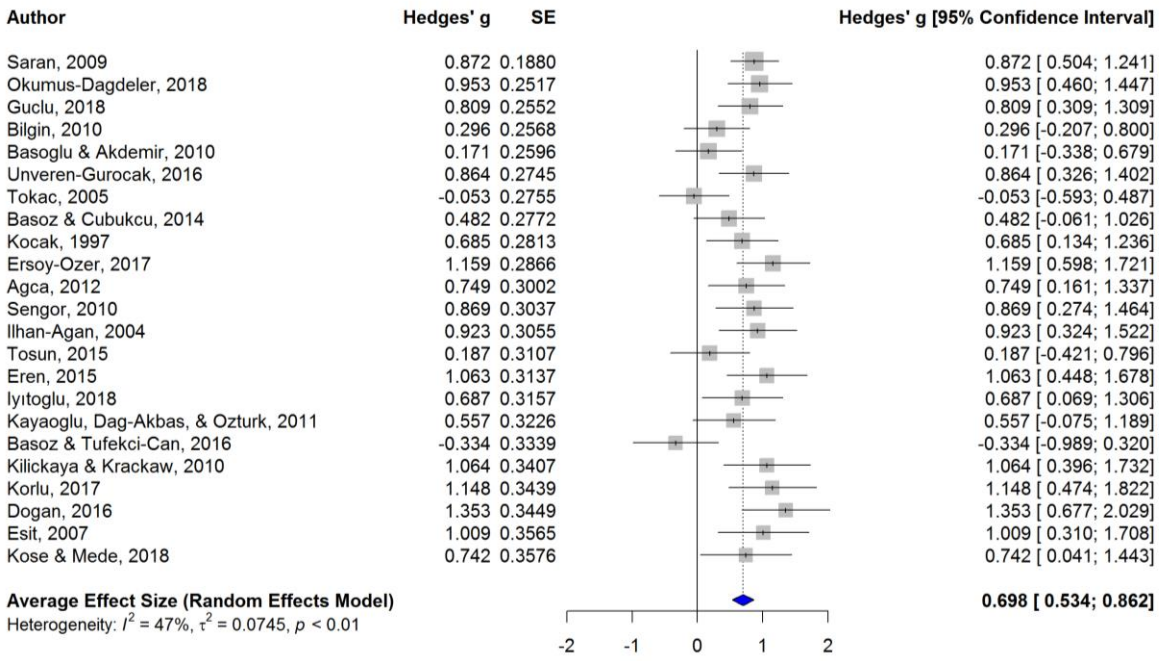
APPENDIX

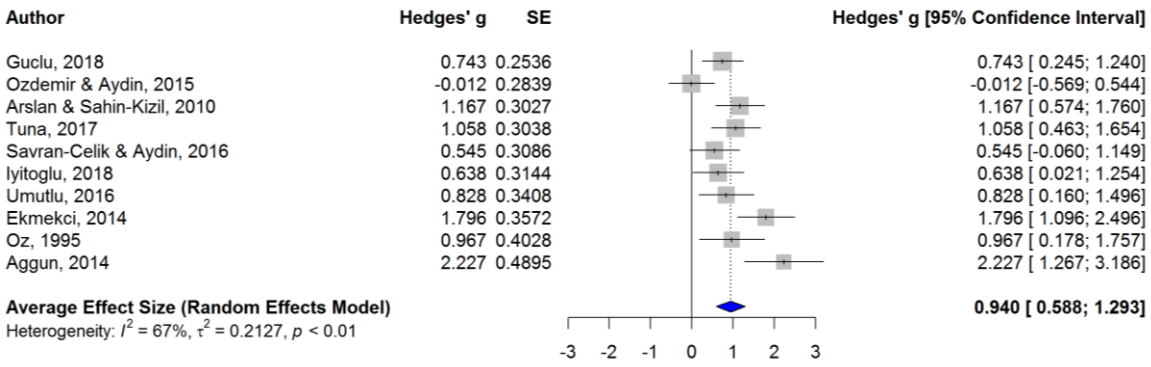
Appendix 1. ***Forest plot of meta-analysis on Grammar Achievement***



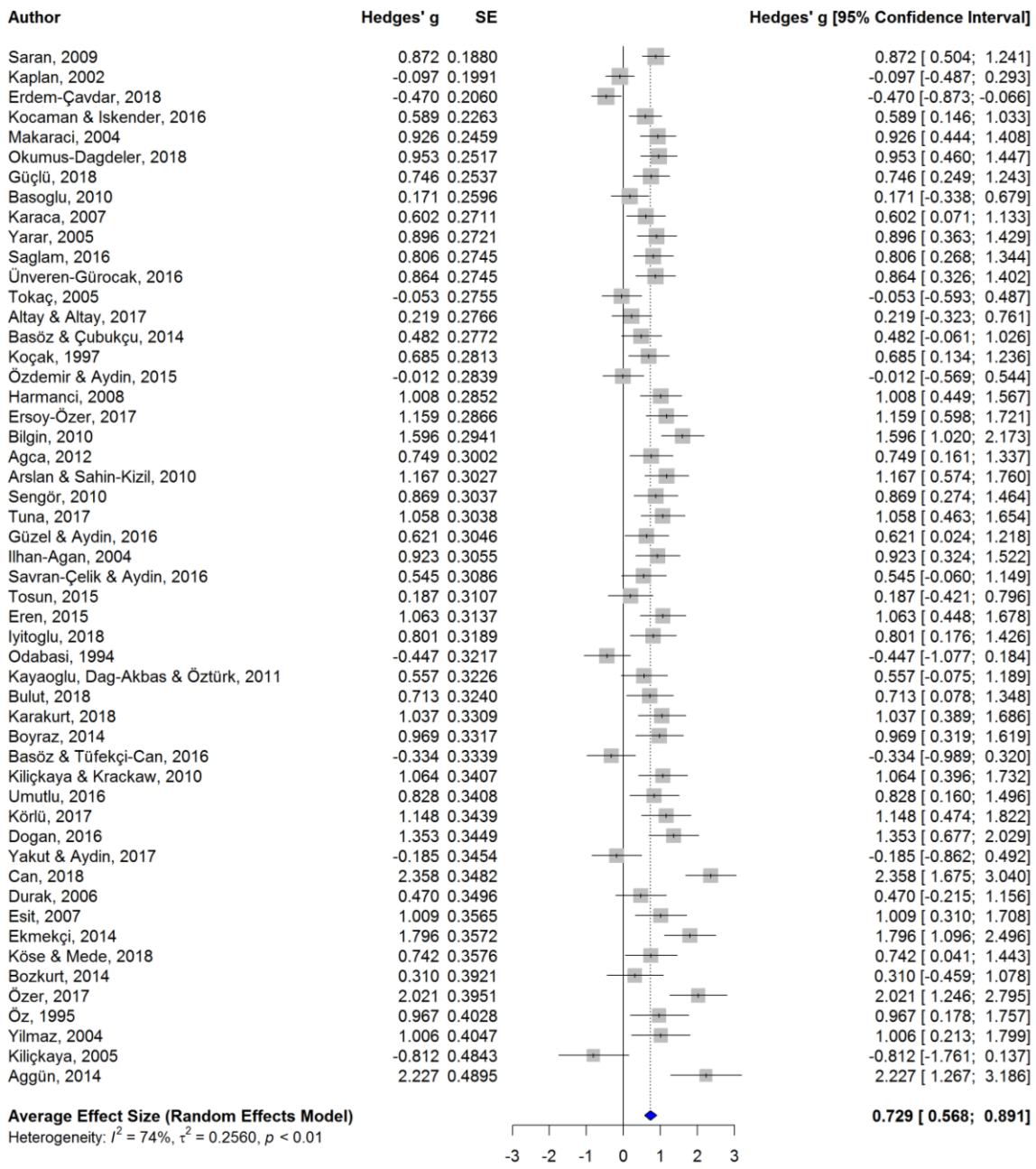
Appendix 2. ***Forest plot of meta-analysis on Vocabulary Achievement***



Appendix 3. ***Forest plot of meta-analysis on Writing Achievement***



Appendix 4. ***Forest plot of meta-analysis on Overall Achievement***



Appendix 5. ***Funnel Plots***